

# AMRAD NEWSLETTER

Amateur Radio Research and Development Corporation Mar/Apr 84

## AMRAD Meetings for 1984

The following is the list of monthly AMRAD meetings (Note that September is not the first Monday, as that is a holiday):

February 6	Hal Feinstein on Spread Spectrum
March 5	
April 2	
May 7	Update on Trenton and Dayton
June 4	Horse Race Preparations
July 2	Heath/Zenith Computer Systems
August 6	
September 10	Digital Data Systems
October 1	
Nov 5	Annual Business Meeting
December 3	

## Upcoming Events

### Maryland Hamfest & Computerfest

Sponsored by the Baltimore Radio Amateur Television Society the Maryland Hamfest and Computerfest will be held Sunday, July 29, 1984 at the Howard County Fairgrounds 15 miles west of Baltimore just off I-70 at RT. 32 on RT. 144.

### October 1 -- Digital Data Systems

The October 1st AMRAD meeting promises to be quite interesting and informative. Bernhard E. Keiser, D.Sc. in electrical engineering from Washington University and a registered Professional Engineer in Virginia, Maryland and D.C., will be our guest speaker. Dr. Keiser has designed microwave communications systems for the military, conducted technical feasibility studies in satellite communications, and has been a consulting engineer in the field of cable television systems technology. He holds two U.S. patents for voice-signal bandwidth compression and expansion using time domain principles. He has 26 published papers. All in all it promises to be an enlightening evening--Bring a friend!

### Personal Computers Banned!

Eastern Airlines among others have banned in-flight use of personal computers because of potential interference to flight navigation equipment caused by RF radiation and leakage from them. This ban is temporary until aircraft manufacturers and airlines conduct comprehensive tests to determine the interference potential. At that point they will decide whether the ban will be made permanent.

If you plan to fly during the ban, you should check with your travel agent or directly with your airline for PC use limitations. The conditions of the ban vary from carrier, with some airlines even forbidding passenger use of hand calculating devices. If you want to work while travelling, it would be wise to stock your briefcase with pencils, legal pads, and an abacus.

### FOR SALE

Model 100 computer with 32k RAM, telephone cables, RS-232, case, power transformer, printer cable, operating and technical manual. \$750. Call Bill (404) 928-8510 nights or (404) 422-6600

## It's a girl!!

Last Saturday at Pizza Hut, I looked around the table and was surprised to see Terry Fox (WB4JFI) holding what looked like a hunchbacked Vancouver TNC board. What it was, in fact, is his newly designed daughter board that plugs into an unmodified VADCG TNC to expand the TNC memory from 4K each of EPROM and RAM to up to 32K of each. In addition, three software programmable timers are also provided. One is used to provide the clock for the 8273 (HDLC chip) on the VADCG TNC. The other two are used to generate timed interrupts for the VADCG TNC (8085). On generates maskable interrupts (INTR pin), while the other generates non-maskable interrupts (TRAP pin). These timers can be used to give the programmer a more accurate method of controlling protocol functions.

In addition, there are several 16 pin sockets, one 24 pin socket, and a general kludge area provided for the user. This allows for additions such as transmitter time-out timers, or modems.

### EPROM Description

There are four EPROM sockets provided. They are spaced so that Zero Insertion Force (ZIF) sockets can be used if frequent EPROM changing is expected. The board uses the present memory decoder chip (relocated onto the daughter board), with a jumper area used to define what type of EPROM is being used. The board comes jumpered for 2732 type EPROMs, but 2716, and 2764 types are also usable. JEDEC 28 pin socket layout is used.

### RAM Description

As in the EPROM area above, the RAM sockets also conform to the 28 pin JEDEC layout. The four Ram sockets will accept either 2K devices (6116 type), or 8K devices (either static or pseudo-static that are Intel 2186 compatible). The RAM address decoder is similar to the EPROM decoder, except that the jumper is set to 6116 type devices. RAM address mapping is set to begin at 8000 hex, to conform with older mods to the Vancouver TNC.

### Timer Description

In addition to the new memory used on the daughter board, an Intel 8253 timer is implemented. This device has three independant software controllable timers, each with a sixteen bit divider. The old hardware baud-rate divider (CD4024) for the HDLC channel has been moved up to the daughter board, and acts as a pre-divider to the 8253 chip. Each of the 8253 timer's clock inputs are jumperable to one of the outputs of the CD4204, allowing timed interrupts over a large variation of times. Timer 0 is now used to generate the clock for the HDLC channel. Timer 1 is normally jumpered to the 8085 trap pin on the VADCG TNC, which is non-maskable. Timer 2 is normally jumpered to the 8085 INTR pin, which creates an interrupt that is maskable by the CPU. The two-interrupt system allows versatile programming techniques to be used, along with better error recovery.

My thanks to Terry for providing a brief description of the AMRAD Vancouver Daughter Board. The initial run of boards are being made now. Watch for ordering information and a complete parts list in the next newsletter. I'll also try to get a schematic for you.

AMATEUR PACKET RADIO IN THE UNITED STATES  
A 1984 PERSPECTIVE  
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Newington, CT 06111

In the U.S., in four year's time, amateur packet radio has progressed from a dead start to perhaps as many as a thousand stations. Hardware and software to implement link-level communications is now readily available from several sources. This paper summarizes the activity of these four years and itemizes some specific areas for further work.

#### SOME HISTORY

Amateur packet-radio communications in the United States got its start in Canada. The Canadian Department of Communications authorized packet-radio operation in 1978 and set in motion Amateur Radio packet experimentation in North America and now around the world. While Montreal-area hams were on packet radio first, Doug Lockhart, VE7APU, and his Vancouver Amateur Digital Communications Group (VADCG) established the pattern which is now widespread use. Key to this were the use of bit-oriented (HDLC-based) protocol and a dedicated special-purpose computer called a terminal-node controller (TNC). About 500 VADCG TNCs have been sold to amateurs throughout the world. Without the VADCG TNC, interested amateurs might be merely thinking of writing packet-radio software for their personal computers.

As of April, 1980, the U.S. Federal Communications Commission (FCC) authorized amateurs to use ASCII including packet-switching techniques. Later that year, two amateur groups were on the air experimenting with packet radio. One, now known as the Pacific Packet Radio Society (PPRS) activated the first U.S. Amateur Radio packet repeater under the call sign KA6M/R in the San Francisco area. In Washington, DC, the Amateur Radio Research and Development Corporation (AMRAD) linked a packet repeater via a conventional 2-meter voice repeater with wide-area coverage. Local-area networks developed in both San Francisco and Washington, DC.

By 1981, it became evident that packet radio interest was growing across the United States. To bring the various experimenters together, AMRAD and the Radio Amateur Satellite Corporation (AMSAT) organized an ARRL-sponsored Amateur Radio Computer Networking Conference in Gaithersburg, MD, in October 1981. Over 80 people, including representatives from Linkoping, Sweden, were in attendance. The conference served to educate people on how to get on the air with packet radio and focussed attention on specific needs. The teamwork and personal friendships developed at that conference were key to rapid growth while maintaining compatibility between different packet-radio groups.

One of the participants at the 1981 conference was Den Connors, KD2S. He returned to his new home in Tucson, AZ, to form the Tucson Amateur Packet Radio Corporation (TAPR). Because Tucson is a high-tech area, Den was able to draw together a capable design team to develop the TAPR TNC. Their beta-test TNC was fully assembled and placed in the hands of about 180 experimenters who fed back design errors, fixes and suggestions for the next mode. Today, TAPR is offering a TNC kit with a well-designed PC board, extensive documentation and mature software -- packaging effort unseen before in Amateur radio. TAPR has supplied about 750 TNCs to hams, worldwide.

In the summer of 1982, AMSAT was preparing for the launch of their Phase IIIB satellite, which became AMSAT-OSCAR 10 on June 16, 1983. AMSAT president, Tom Clark, W3IWI, was concerned that there wouldn't be any standards for packet-radio operation through the new satellite. He invited the major U.S. packet-radio groups to get together just prior to the AMSAT annual meeting in October 1982 to see if common modulation and protocol standards could be agreed. Because of their abundance, North American Bell 202 modems were chosen as the interim standard until they could be replaced by more effective modems (probably using MSK or PSK). It was determined that SSB transmitters would be needed to transmit

transmitters which would give poor performance through the satellite. Various packet protocols were proposed, but the group accepted AMRAD's AX.25 link-level proposal with some modification. AX.25 link-level uses Amateur Radio call signs in the frame address field. At the conclusion of the meeting, the address field included the called station, the calling station and an optional repeater station.

At the same AMSAT meeting, Tom Clark proposed the concept of a new packet-radio satellite, now known as PACSAT. While highly elliptical or geostationary orbits were preferred for conventional voice or CW QSOs, low-earth-orbit satellites could be used for store-and-forward packet radio communications. The packet experimenters agreed to support the general concept and developed some system-development goals. The idea won approval by the members at the AMSAT annual meeting, and PACSAT was hatched. Much has happened since then in finding financial backing (from Volunteers In Technical Assistance -- VITA) and system design. The program manager for PACSAT is Harold Price, NK6K. PACSAT is now scheduled for a 1986 launch.

Organized by AMRAD and PPRS, the Second ARRL packet conference was held in San Francisco, in April 1983. This conference made note of TAPR's Beta Test program, several implementations of the new AX.25 link-level protocol, and a widespread desire to extend packet radio beyond local-area networks. In July, in Redondo Beach, CA, California packeteers met to launch WESTNET -- a chain of packet repeaters connecting stations from San Diego to north of San Francisco. Lack of an agreed network-level protocol led the participants to agree on extending the AX.25 link-level address field to as many as 8 repeaters. This modification to the AX.25 link-level protocol was reviewed and accepted by the ARRL Ad Hoc Committee on Digital Communications, in November 1983, as a temporary "kludge" that would be eliminated when a network-level protocol is agreed.

The Digital Committee also discussed anomalies noted by the different implementers of the AX.25 link-level protocol and were able to iron out everything except how to use the poll/final (P/F) bit. The question of the P/F bit was left unresolved until the weekend of April 14-15, 1984, which included a Digital Committee meeting and the Third ARRL Amateur Radio Computer Networking Conference in Trenton, NJ. Phil Karn, KA9O, explained his proposal to Terry Fox, WB4JFI, writer of the link-level protocol definition, who agreed that Phil's solution is practical. This marks the completion of a long series of negotiations by those involved in defining and implementing AX.25 link-level protocol.

At this point, there are two other TNC boards and a software counterpart available commercially. The two TNC boards are by Bill Ashby & Son and by GLB Electronics; a software "TNC" is available from Richardson Engineering, Ltd. These products support both Vancouver and AX.25 protocols, and I estimate that each has been sold in quantities exceeding 150. Thus, the total number of TNCs and software equivalent sold is now about 1700. Discounting those that were purchased in kit form and not assembled as well as other problems, I estimate that there are now 1300 packet-radio stations that are capable of operating and that about 1000 of these are in the U.S.

#### WHERE DO WE GO FROM HERE?

It's anyone's opinion. In fact, it will be the individual and collective opinions of packeteers that will shape the emerging worldwide network. Here are my ideas of the significant things that are happening and things that should be done in the next year or so.

\* Intranet and internet protocols are needed. The only proposal put forward so far is a CCITT X.25-based protocol, which is completely described in the proceedings of the Third ARRL Amateur Radio

\* VHF/UHF backbone networking is beginning to develop. The New England Packet Radio Association (NEPRA) is working on a 9600-baud FSK modem design. We are presently limited to this speed because that is the fastest that various TNC boards will go without redesign. I would like to see backbone networks operate at the U.S. legal speed limit of 56 kbauds. Dave Borden, K8MMO, is working on a packet assembler/disassembler for this speed; someone is needed to work on a companion modem.

\* A New modem is required for HF packet-radio operation. The Bell 202 and 103 modems now in experimental use have inadequate noise performance. My packet adaptive modem (PAM) will be generally available later this year.

\* HF packet radio experimentation has just begun. The center of most recent activity has been Bob Bruninga, WB4APR. Preliminary test results suggest that best results will be obtained by operating at speeds higher than 300 bauds. While it is true that more multipath is encountered as the signaling rate is increased, intersymbol distortion comes and goes with fading. I expect that further experimentation will show that 1200-baud burst operation will yield more throughput than slower speeds. A number of stations are planning to ask the Federal Communications Commission for Special Temporary Authority for HF operation up to 1200 bauds.

\* Successful HF operation will require both ARQ and FEC types of operation. Fading and burst-error statistics must be studied to develop timing strategies, which may have to be adaptive to path conditions.

\* New modems are needed for packet-radio operation via satellites. Significant work is being done by Phil Karn, KA9Q. His 9600-baud PSK modem is now ready for PC-board layout. Slower

\* Meteor-scatter packet radio needs to be developed. Several U.S. groups are interested in experimenting, but MS is not yet beyond the talk stage. We are mindful of MS work done by European amateurs and commercially.

\* Study should be given to integrating analog communications into the digital network. This would include digital voice, slow-scan TV, and compressed-bandwidth TV (i.e., 56 kbit/s). Packet-radio experimenters should give special attention to Videotex techniques and make operational use of them as soon as reasonably priced chip sets become available.

\* Some work is needed to develop transport, session, presentation and application-layer protocols.

\* A standard message format is desirable. There are now quite a few different formats in use when landline bulletin boards, packet-radio bulletin boards, ARRL National Traffic System, and commercial packet-switching networks are counted. Some packeteers are involved with all of them. Refiling messages from one network to another necessitates tedious message formats. We are watching the work done by the CCITT in this regard. The ARRL Digital Committee is expected to debate various possibilities later this year.

#### CONCLUSION

Amateur packet radio, as we know it in the United States, is alive and well. It is currently in the hands of experimenters who have much more work to do before it can become a popular operating mode for amateurs.

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**AMRAD**

**Amateur Radio Research and Development Corporation**

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# A Solution to the Poll/Final Problem

Phil Karn, KA9Q

AMSAT

This article proposes a solution to an oversight in the original AX.25 Level 2 protocol having to do with the proper use of the Poll/Final bit and the distinction between command and reply frames.

For those of you unfamiliar with the problem, here's a short primer. The P/F ("Poll/Final") bit in the control field of each X.25 LAPB frame is provided for asking the status of the other end of a link, particularly after a timeout. When the P/F bit is set to elicit a response from the other end of the link, it is referred to as the P-bit and the frame becomes a "command frame". The other end must send a "response frame", also with the P/F bit set, which in this case becomes an F-bit. Since the Poll and Final functions share the same bit, there must be some indication as to whether the frame is a command or a response. For unnumbered frames, there is no problem; SABM and DISC are always commands, while UA, DM and FRMR are always responses. An I-frame is always a command. (UI, which is not defined in X.25 LAPB, should probably be considered a command, but this doesn't really matter here.) However, a supervisory frame (RR, RNR or REJ) can be either a command or a response, so some other mechanism is necessary to resolve the ambiguity.

In an X.25 LAPB frame with the P/F bit set, the distinction is made by looking at which address (yours or his) is present in the address field. If it contains your address, the frame is a poll command to which you must respond; if it contains the other station's address, it is the response to your poll. One cannot "guess" from the context of the frame (i.e., whether or not you're expecting a response to an earlier poll) because both stations might poll each other simultaneously, a very likely possibility if a momentary link failure or QRM affects both transmission directions.

Unfortunately when we invented the addressing scheme for AX.25 we lost this information. The address fields are always the same - they contain both callsigns. Therefore you cannot reliably determine if a frame you receive with the P/F bit set is a command or a response. While X.25 LAPB does provide for an alternate way to recover after a timeout (by sending ONLY the oldest unacknowledged I-frame in hopes of generating an S-frame response with an indication of what the receiver expects) there are reasons for a better solution.

1. Resending unacknowledged I-frames after a timeout can result in inefficient use of the channel, particularly if the timeout was due to the receiver's acknowledgement being lost. In addition, the TAPR implementation (and probably others) appear to resend ALL unacknowledged data, which is specifically forbidden under X.25 LAPB.

2. When the remote end becomes busy (say, due to a slow printer), it sends a RNR (receiver not ready) to flow control the sender. X.25 LAPB requires the sender to wait for a RR (receiver ready) before sending more information. The sender may not transmit any more I-frames before getting explicit permission from the receiver in the form of an RR frame. Since this RR frame could get lost, the sender could wait forever; therefore it must take the responsibility to periodically poll the other end to see if the busy condition still exists. Polling with the P/F bit takes much less channel bandwidth than continually resending unsolicited I-frames in the hopes that the receiver might be ready for them.

Right now, this isn't too much of a problem because our links are generally slower than our computers or terminals. However, when our link speeds surpass our computer or terminal rates and flow control becomes common, we'll find ourselves wasting a lot of the extra channel capacity on retransmitted I-frames.

To resolve these problems I am formally proposing the following revision to the AX.25 standard. Basically, I am proposing that a reserved bit in the SSID byte of the source and destination address fields contain the information formerly provided by the address field of X.25 LAPB. This can be done in an upward compatible way, preserving compatibility with existing

For the purposes of this proposal, bits within octets (bytes) of the address field are numbered from 1 to 8, with bit 1 being the least significant bit (the address extension bit). Currently, there is no use for bit 8 in the SSID octets of the source and destination fields (this is the "H" or "has been repeated" bit in repeater fields.)

An upward-compatible AX.25 station would determine if the station it is in communication with adheres to the revised standard by comparing bit 8 in the source address SSID with bit 8 in the destination address SSID in received frames. Since the present standard calls for these bits to be set to 0, equality would indicate that the other station is an "old" implementation and the "new" station would act accordingly (i.e., according to present procedures).

However, if the bits differ it can then determine if a given frame is a command or response by whether the source or destination SSID field has bit 8 set, using rules analogous to LAPB. In other words, if LAPB would call for a given frame to be sent as a "command", i.e., with the other station's address in the address field, bit 8 in the destination SSID byte is set to one and bit 8 in the source SSID is set to zero. If LAPB would call for the frame to be sent as a "response", bit 8 in the source SSID would be set to one and to zero in the destination SSID.

Summarizing in tabular form:

AX.25 (revised):	Direction	Command	Response
	A->B	B	A
	B->A	A	B

AX.25 (revised):	Command (either direction)	Response (either direction)
dest SSID bit 8	src SSID bit 8	src SSID bit 8
1	0	1

Note that the same callsign (that of the commanded station) would have bit 8 of its SSID set in both the command frame and its response. This is because the commanded station's callsign occupies the destination field of the command, while it occupies the source field of the response. On the other hand, bit 8 of the commanding station's SSID byte would be zero in both the command and response frames.

Since all X.25 frames are classed as either "commands" or "responses", even when there is no ambiguity (e.g., I-frames are always commands), all AX.25 frames should also be marked as such. The UI frame, which is not defined in X.25, is defined as a command frame for this purpose.

In summary, this proposal has the following advantages:

1. Upward compatibility with existing implementations of AX.25 which comply with the "old" requirements concerning reserved SSID bits.
2. Complete conceptual conformance to LAPB with respect to "commands" and "responses" when communicating with other stations also following this revised protocol.

The AX.25 address which is "marked" by bit 8 in its SSID byte corresponds to the choice of address "A" or "B" which would normally be used in LAPB. This allows much closer adherence to well-established LAPB procedures for link recovery and flow control, and much better channel utilization under these conditions.

3. Compartmentalization to the greatest possible extent of the differences between AX.25 and CCITT X.25 caused by the former's specialized addressing scheme. This would allow more structured implementations that draw upon existing procedures and software developed in non-amateur X.25 networks.

**The Amateur Radio Research and Development Corporation (AMRAD)** is a worldwide club of over 500 amateur radio and computer experimenters. It is incorporated in Virginia and is recognized by the U.S. Internal Revenue Service as a tax-exempt scientific and educational organization.

**The purposes of AMRAD** are to: develop skills and knowledge in radio and electronic technology; advocate design of experimental equipment and techniques; promote basic and applied research; organize technical forums and symposiums; collect and disseminate technical information; and, provide experimental repeaters.

**Meetings are on the 1st Monday** of each month at 7:30 P.M. at the Patrick Henry Branch Library, 101 Maple Ave E, Vienna, VA. If the first month is a holiday, an alternate date will be announced in the newsletter. Except for the annual meeting in December, meetings are normally reserved for technical talks - not business.

**WD4IWG/R** is an open repeater for fm voice and digital communications, especially for experimental modes. It is located at Tyson's Corner, McLean, VA. It features semi-private autopatch available to licensed members. Frequencies are: 147.81 MHz in, 147.21 MHz out. The repeater director is Jeff Brennan, WB4WLW.

**WB4JFI5/R** is a 1200-baud half-duplex packet repeater located on the south leg at the 200 ft. level of the WDVM/WJLA TV tower. The tower is located at Wisconsin Ave. and River Rd. in northwest Washington DC, and the repeater runs the AX.25 level 2 protocol. The frequency for the WB4JFI5 packet repeater is 145.01 MHz simplex.

**The AMRAD CBBS, 703-734-1387,** is operated by Terry Fox, WB4JFI. The system accepts 110, 300, 450 and 600-baud ASCII, Bell 103.

**Handicapped Education Exchange, 301-593-7033,** is operated by Dick Barth, W3HWN. HEX accepts 110/300-baud ASCII and Baudot deaf TTY/TDD calls.

**AMRAD is affiliated with the American Radio Relay League (ARRL), Foundation for Amateur Radio (FAR), Northern Virginia Radio Council (NOVARC) and the Mid Atlantic Repeater Council (T-MARC).**

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